Shopping Trip Chains: Current Patterns and Changes Since 1970

Hyungjin Kim, Ashish Sen, Siim Sööt, and Ed Christopher

National demographic patterns are changing. In absolute terms household and automobile growth exceeds population growth, resulting in an increase in the number of trips and traffic congestion. The evidence from the Chicago region, however, suggests that the number of trips per capita has not changed in 20 years, trip chains per capita are declining, travel per households has declined, and perhaps most surprisingly shopping trips per capita have declined noticeably. However, through increasing trip-chain complexity, more out-of-home destinations are reached with a constant number of trips, indicating a higher degree of trip mobility. Trip making is becoming more efficient, and the time spent shopping is not increasing even with fewer per capita shopping trips. Although many of these trips are conducted during the peak and add to congestion, since they are chained with the work trip, moving these trips to the off peak may increase vehicle miles of travel (VMT). Moreover, relatively few trip chains follow the minimum path, thereby adding to VMT. These conclusions are drawn from 1970 and 1990 household travel data collected by the Chicago Area Transportation Study for DuPage County, a fast-growing area west of Chicago. The authors encourage others to examine the temporal changes in travel behavior in their locales.

During the last several decades the transportation community began to change its focus of travel analysis from individual trips to trip chains. This change acknowledges the importance of multipurpose trip making. Concurrently there has been a proliferation of models addressing trip chaining (1–4). Although considerable strides were made in modeling this behavior, the demographics and the demand for transportation services have changed, affecting these model constructs. The number of jobs has grown disproportionately to population growth as women have entered the labor force in large numbers. Rapid job formation encouraged the automobile population to grow rapidly, which contributed to a decline first in transit use and subsequently in carpooling. All of these factors together with the new questions being asked regarding the environmental effects of travel suggest a need to review existing travel demand models.

The purpose of the study described here is to examine some of the current chaining characteristics as they describe shopping trips and more generally to identify some of the changes in trip chaining behavior since 1970. Although the emphasis is on current shopping trips, other trips are also examined, particularly in contrasting 1970 and 1990 data. The study concludes that as the number of work trips per capita has increased, the number of shopping trips has declined, despite the implicit increase in income stemming from job growth. Moreover, the time spent shopping is not increasing, despite the declining frequency of these trips. As has been asserted by many (5–7), changes in household structure have

resulted in modifications in trip-making behavior, but as discovered here, because trips are increasingly linked together, there has been little change in the number of trips per person. Nevertheless the number of out-of-home stops has increased, made possible by increasing chain complexity. Mobility seems not to suffer since more destinations are reached with fewer trips and chains.

Lastly in the study of shopping trips and chains it is inevitable that one becomes involved with other trip purposes. Shopping chains frequently include many nonshopping stops.

BACKGROUND: TRIP CHAINING

Definitions

Several terms need to be defined or clarified before proceeding. First, a *chain* is defined as a series of trips that begin and end at home. A *trip* is the movement or link from one stop to another. A *shopping trip* is a trip in which shopping is the purpose at the destination. Second, chains can consist of any number of stops and may have any combination of purposes. Shopping chains, then, may have numerous nonshopping stops but at least one stop must be to shop. Third, home-to-shop-to-home is a simple shopping trip chain; complex chains have more than two out-of-home stops. Home-to-work-to-bank-to-shop-to-home is an example of a complex shopping trip chain. Because of the process of linking stops together and the definitions, shopping stops constitute a minority of nonhome stops in complex chains.

Previous Studies

A wide variety of approaches has been developed, beginning largely from a Markovian base (8,9). Subsequently advances were made in formulating the theoretical basis for trip chaining (10,11), and a method has also been provided to estimate the amount of trip chaining (12). Many of these papers include extensive discussions regarding previous work (13,14), including trip chaining as it pertains to pedestrian travel (15); therefore, it is not necessary to restate these developments.

Two studies merit attention, however. These empirical studies have examined trip chaining with data collected in the last ten years. Strathman et al. (7) examined data collected in Portland, Oregon, and addressed the degree to which nonwork trips were chained to work trips. Compared with DuPage County, Illinois, the Portland study found a lower propensity to conduct complex chains: 24 percent of all trip chains versus 37 percent in DuPage County. Simple chains to work and to shop, however, were found in similar proportions. Home-shop-home accounted for 9.6 per-

H. Kim, A. Sen, and S. Sööt, Urban Transportation Center, MC 357, 1033 West Van Buren Street, Suite 700, University of Illinois at Chicago, Chicago, Ill. 60607-2919. E. Christopher, Chicago Area Transportation Study, 300 West Adams Street, Chicago, Ill. 60606.

cent of all trip chains in Portland and 9.0 percent in DuPage County. The respective figures for simple work trip chains are 25.1 and 23.0 percent.

The recent examination of travel data collected in the Seattle region between 1986 and 1989 shows the greatest amount of chaining by women in suburb-to-suburb trips and the fewest complex chains by men from the suburbs to the city (*16*). It also identified a high frequency of trip chaining by women during the midday. Given the general propensity to trip chain, it was concluded that transit could not well serve complex chains and that transit potential was consequently negatively affected by this phenomenon.

DATA AND STUDY AREA

Household and Survey Data

The data used for the present analysis were extracted from two different travel data bases used by the Chicago Area Transportation Study (CATS), the metropolitan planning organization for northeastern Illinois. The first set of data was selected from a CATS 1970 home interview survey that contained a 0.8 percent sample, or 17,385 households. For just over 20 years it was this data base that was used by CATS in most of its travel forecasting and planning work. A total of 1,110 households represent DuPage County, the area examined in the study.

The second data source was the recent (1988 to 1991) CATS Household Travel Survey, which consisted of a 0.7 percent sample of households regionwide and a 1.7 percent sample in DuPage County. For the region this data base contained information from 19,313 households, of which 5,098 were in DuPage County. Table 1 presents the size of the data bases with a focus on the expanded number of trips and trip chains in DuPage County.

Both surveys and their resultant data bases have been well documented, and each carries a wealth of information (*17–19*). For the 1990 data only the DuPage County portion has been factored and adjusted. Consequently these data are preliminary. However the final data are expected to closely match the preliminary set.

DuPage County

For the decade of the 1980s DuPage County demonstrated one of the largest absolute population gains outside of the Sun Belt states. In 1970 the county had 491,882 residents and 199,352 workers (Table 2). By 1990 the population had swelled to 781,666 people, 425,284 of whom were employed. In terms of jobs the increases were staggering. In 1970 there were approximately 115,200 jobs, which grew to 528,444 in 1990, an increase of 359 percent (*20*). DuPage County is representative of a fast-growing suburban community.

SUMMARY OF 1990 SHOPPING TRIPS AND CHAINS

A review of the number of shopping trips and shopping chains in DuPage County reveals that trip chains are for a variety of purposes and that only a small proportion of chains are for a single purpose. There are a total of 619,170 trips in the shopping trip chains, but only 36.6 percent (226,399) of these are shopping trips. Further examination reveals that 58.7 percent of the shopping trips are made in conjunction with other purposes. Shopping *chains* include nonshopping activities, whereas shopping *trips* refer only to trips with shopping at the destination.

Trip and Chain Lengths

At least two aspects of trip and chain lengths are of importance: (a) the number of miles and (b) the degree of distance minimization in the trip chains. The trip lengths were derived by determining the quarter-square-mile origin and destination zones and then computing the airline distance between the zone centroids. Distance minimization pertains to the sequence of stops and how closely this route comes to the minimum path through the stops.

Trip Lengths

An examination of trip lengths by link and chain size reveals important patterns. The first link was only 2.51 mi in simple

TABLE 1 DuPage County Data Bases, 1970 and 1990

Description	Number of Households		Number of Trip Chains		Number of Trips	
	Universe	Sample*	Total	Shopping	Total	shopping
1970 Survey Regionwide	2,183	17,385*	6,798	1,676	16,757	2,101
DuPage County	142	1,110*	619	171	1,518	210
1990 Survey Regionwide	2,773	19,313*	NA	NA	NA	NA
DuPage County	279	5,098*	792	184	2,178	226
Percent Increase in DuPage County	96%	–	28%	8%	43%	8%

* All numbers in thousands except for sample size

Source: Chicago Area Transportation Study (CATS) 1970 Home Interview data base, 1990 Household Travel Survey results and Preliminary factored results for DuPage County 1990 data.

TABLE 2   DuPage County Population Characteristics, 1970 and 1990

	1970	1990	% Change
Population	491,882	781,666	58.9
No. of HH.	142,408	279,344	96.2
No. of Person per HH.	3.41	2.76	
No. of Workers	199,352	425,284	113.3

chains and 2.89 mi in complex chains, indicating the prevalence of trips to nearby retailers in simple chains. In complex chains not only is the first link longer as the chain becomes more complex but each subsequent link distance is longer except for chain size 6, in which sample size begins to play a role (Table 3). Since the return trip home is frequently not the longest trip in the course of these chains, however, the trip maker begins to travel homeward before the last link.

Minimum Path Behavior

Given the stops made during the course of the day, several authors (*13,21*) have examined the propensity to minimize travel distance in connecting these stops and found that many trip makers do not utilize the minimum distance.

Figure 1 illustrates numerous possible trip chains given five stops. The minimum covers a distance of 39 units and consists of connecting the nearest unvisited stop. The maximum travel distance covers 60 units, yielding a range of 21 units between the minimum and the maximum. These maximum-distance paths are frequently chosen when there is a necessary chronology to the stops made or if the entire chain cannot be planned and trips are made spontaneously. A path requiring 44 distance units is illustrated in Figure 1, and visual inspection reveals that it is close to the minimum. Since it is 5 units longer than the minimum, it is 24 percent of the length of the range from the minimum to the maximum. Similarly there are other sample paths in Figure 1; their distances and the portions of the range covered are again expressed as a percentage.

The evidence in DuPage County indicates that distance minimization decreases with the complexity of the chain (Table 4). Chain sizes 4 to 6, for which the sample size and degree of complexity permit comparisons, show minimum distances declining from 47.3 percent of the trips to 8.8 percent. Similarly the maximum-distance chains also declined from 21.7 to 2.7 percent. The major gains occur in the middle levels, in which the distance traveled is 20 to

TABLE 3   Mean Trip Lengths of Shopping Trips by Trip Chain Sizes

Chain Size	Link 1	Link 2	Link 3	Link 4	Link 5	Link 6
2	2.51	2.51*				
3	2.76	3.75	2.73*			
4	3.09	3.41	3.63	3.71*		
5	2.81	2.65	3.62	3.81	4.00*	
6	5.44	3.55	2.97	3.34	4.73	4.21*

Only trip chain sizes 2 to 6 included in this table
* Returning home trip; not a shopping trip
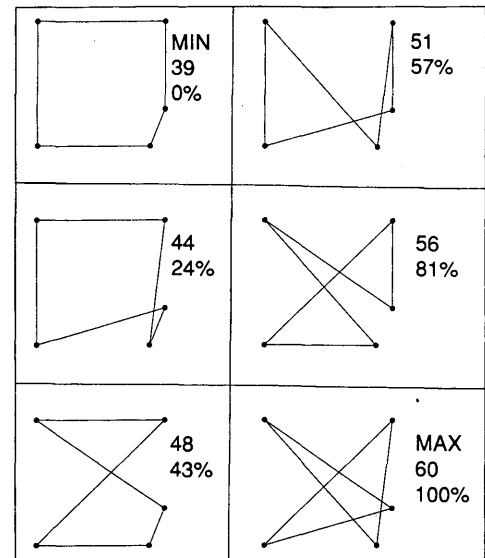Unit = zone centroid to centroid airline distances in miles

FIGURE 1   Six path choices with travel distances and percentage of range from minimum to maximum.

60 percent of the range from the minimum to the maximum distance.

Table 4 also indicates that distance minimization is more common when the differences between minimum and maximum distances are high. When distances are maximized, on average, the distance that could be saved by minimizing is 4.5 mi or less. Conversely when total travel is at the minimum or close to it, the maximum distance would frequently be more than 10 mi longer.

A closer examination of the differences between distance maximization and minimization reveals that work trips are a part of the maximum-distance shopping chains 66 percent of the time (chain size of 4, Table 5). In fact in chain size 4, which includes a work trip, there are almost equal numbers of minimum and maximum chains. It is likely that few of these trip makers have a choice in altering their trip sequences.

TABLE 4   Distance Minimization in Path Chosen by Shoppers by Chain Sizes

Frequency of Chosen Paths (in percent)						

Chain size	Mini- mum	0 – 20%	20 – 60%	60 – 100%	Maxi- mum	Number of Chains
4	47.3	21.3	5.8	3.8	21.7	520
5	16.7	35.5	21.8	16.4	9.5	293
6	8.8	42.2	33.3	12.9	2.7	147

Mean Values of Range between Maximum and Minimum Distance

Chain size	Mini- mum	0 – 20%	20 – 60%	60 – 100%	Maxi- mum	Number of Chains
4	3.7	6.7	1.7	1.7	2.6	520
5	7.3	12.7	6.0	4.4	4.0	293
6	11.2	20.0	9.8	8.3	4.2	147

TABLE 5 Path Choice Behavior of Shopping Trip Chains by Chosen Path Category (chain size of 4)

Description		Mini-mum	0 – 20%	20 – 60%	60 – 100%	Maxi-mum
Number of Trip Chain		246	111	30	20	113
Number of Work Trips		74	32	10	9	75
Activity Time (minute)		237	252	274	349	324
Mean Distance of Trip Chains		13.9	18.3	14.4	21.9	18.9
Mean Distance between Min and Max		3.7	6.7	1.7	1.7	2.7
Number of Trip-chains by Distance Traveled (miles)	0 - 5	34	10	2	2	11
	5 - 10	79	27	9	4	26
	10 - 20	89	37	15	5	38
	20 - 30	22	18	2	3	19
	30 +	22	19	2	6	19

Socioeconomic Characteristics of Individuals

Mean Age		46.2	46.5	43.3	47.1	43.1
Number of Trip-chains by Gender	Male	62	37	8	7	38
	Female	184	74	22	13	75
Number of Trip-chains by Employment status	Full Time	99	52	14	8	58
	Part Time	53	15	5	4	17
	Homemaker	69	28	9	3	32
	Student	24	9	4	1	16
	Retired	48	26	2	4	14

Further contrasting the minimum and maximum trip chains reveals that maximum trip chains are longer both in travel distance and in time duration at the stops (Table 5). Also those making maximum-length trips tend to be younger and are more likely to be men and employed full time than those making minimum-distance trips.

Trip Sequence

The DuPage County data indicate a clear sequence in most chains. When work is included in the chain, in the majority of cases shopping occurred after rather than before work. Table 6 illustrates the rates of occurrence for all possible four-trip chains and the high and low extremes for five-trip shopping chains. Almost uni-

TABLE 6 Frequency of Sample Shopping Trip Chains

Chain Size	Chain Type	Percent
4	H-S-X-S-H	4.8
	H-S-S-X-H	6.0
	H-S-S-S-H	6.5
	H-S-X-X-H	9.2
	H-X-S-S-H	14.4
	H-X-S-X-H	26.9
	H-X-X-S-H	32.1
5	H-S-S-S-S-H	2.0
	H-S-X-X-X-H	6.1
	H-X-X-S-X-H	19.1
	H-X-X-X-S-H	31.7
6	H-X-X-X-X-S-H	21.0

H = home,   S = shop,   H ≠ X ≠ S

formly the highest rates were with shopping occurring near the end of the chain, and low rates were common for shopping occurring early in the chain.

For chain size 4, in 26.5 percent of the cases shopping occurred on the first stop, but in 57.8 percent of the cases it occurred at the last stop preceding the trip home (Table 6). Considering all complex shopping chains, in the majority of chains shopping was the last stop before returning home. Conversely a sizable percentage of shopping is independent of the home location. In 26.9 percent of the chains (chain size 4) the home was not the preceding or the subsequent stop.

COMPARISON OF 1970 AND 1990 TRIP-CHAINING BEHAVIOR

In the Chicago area there is a long tradition of transportation and socioeconomic data collection and analysis. The 1990 Household Travel Survey follows in that tradition and provides an opportunity to examine changes in travel behavior.

Several modifications in data collection procedures merit discussion. First, the 1970 effort was a home interview, whereas the 1990 data were collected by a mail-out–mail-back survey; both sets of data were subject to an extensive factoring procedure. Second, the 1990 survey dropped personal business as a trip purpose and added banking and eating out. In a pretest too many individuals interpreted personal business to mean work activity, and it was consequently deleted and the purpose choices were therefore changed. Because of the extent to which banking or eating out may have incorrectly contributed to shopping in 1970, the 1990 data are more clearly defined as shopping and consequently shopping as a destination category may be recorded slightly less. Conversely the 1970 data were collected over the entire 5-day work week, but the 1990 effort included only Thursday travel, a tradi-

tional shopping day in the Chicago-area market. It is likely that these two counteracting effects may balance, and if they do not, there may be a slight bias toward more shopping being recorded in the 1990 data. The authors found, however, the since per capita shopping trips have declined, there is little evidence of a pro-shopping bias. As a whole care must be exercised in drawing precise comparisons from data such as these.

Changes in Numbers of Trips and Trip Chains

With the population expansion there has been a growth in the number of daily trips, from 1.5 million to 2.2 million, and an increase from 619,000 to 792,000 trip chains (Table 1). Nevertheless this represents a decline in several categories: trip chains per household, trips chains per person, and trips per household (Table 7). The only rate that remained stable was trips per capita.

On the surface this may seem surprising but it is in keeping with (a) the trends displayed by the Nationwide Personal Transportation Survey (NPTS) (22) and (b) the expectation that trips would be bundled into chains as time constraints mount. The 1983 NPTS shows a decline in the number of trips per capita from the 1977 survey, but the 1990 NPTS figure is approximately 5 percent higher than that in 1977. Suffice it to say that given large increases in the automobile population, there has been remarkably little change in the number of trips per capita on the basis of both NPTS and DuPage County data.

The declines in the other three rates may be attributed to demographics. The trips and trip chains per household rates are declining because of smaller household sizes. The decline in per capita trip chains is plausible even with increasing mobility. Figure 2 illustrates two hypothetical households. Household A completes three simple chains, visiting three out-of-home destinations. Household B, however, completes only one chain with five trips but visits one more out-of-home site. It is therefore possible to visit more sites with fewer chains and with fewer trips. This has occurred in DuPage County. Although the number of trips per person has declined modestly, from 4.3 to 4.2 trips per day per person, there has been a 13 percent increase in the number of out-of-home sites visited between 1970 and 1990. This marks a significant modification in which individuals can reach more destinations with less travel; that is, they are more "mobile" but travel less.

Changes in Shopping Chains

With increased trip chaining each excursion from the home includes more destinations, and the instances of travelers conducting
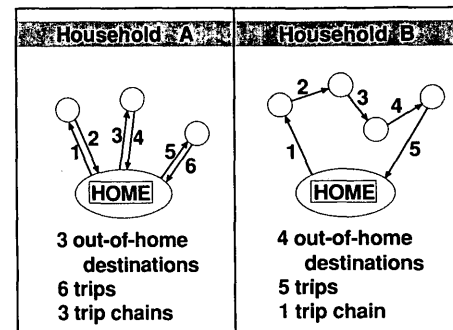

FIGURE 2 Two hypothetical trip patterns.

a trip for only one purpose on a chain are decreasing. The authors are therefore rather liberal in their definition, which includes all chains that have at least one shopping destination; many shopping chains include more nonshopping stops than shopping stops.

Numbers of Shopping Chains and Shopping Trips

As with all travel shopping chains and shopping trips have increased since 1970 but not always in proportion to population. There has, however, been a dramatic decline (30.6 percent) in the number of simple shopping chains (Table 8). Other simple chains have increased in number such as trips to work, but the practice of going to a store and returning has declined even with the large population increase.

To compensate there have been significant increases in the number of complex shopping chains, most noticeably in chains with four and more destinations, all of which have more than doubled in number. Still an increase of only 8 percent in the number of shopping trips is unexpected. Increasing from 210,000 to 226,000, the rise does not reflect the 60 percent increase in population, let alone the increasing disposable income brought about by increased participation in the labor force.

Duration of Shopping

The number of shopping trips per capita has declined even with the proliferation of shopping centers and scattered retailing sites. It would seem reasonable that to accommodate the needs met by shopping, the amount of time spent shopping might increase. Miti-

TABLE 7 Comparisons of 1970 and 1990 DuPage County Daily Travel Data

Variable	1970	1990
No. of Trips*	1.5	2.2
No. of Trips/Person	4.3	4.2
No. of Trips/Household	10.3	9.1
No. of Chains/Person	1.8	1.3
No. of Chains/Household	4.3	2.8
No. of Trips/Chain**	2.3	2.9

* Number in millions
** Change mode is excluded

TABLE 8 Number of Trip Chains per Day in DuPage County, 1970 and 1990

Chain Size	All Chains			Shopping Chains		
	1970	1990	Percent Change	1970	1990	Percent Change
2	481,582	499,216	+3.7	102,986	71,484	-30.6
3	85,200	137,905	+61.9	47,573	53,381	+12.2
4	32,828	83,910	+155.6	12,815	28,122	+119.4
5	10,491	33,857	+222.7	4,443	15,349	+245.5
6+	9,299	37,168	+299.7	3,453	16,653	+382.3
Total	619,400	792,056	+27.9	171,270	184,989	+8.0

gating against that is the increase in the number of people in the labor force and the consequent constraints on time to shop. Also as chain complexity increases, the average time spent at each stop tends to decrease.

The 1990 CATS survey shows an average amount of time spent at the shopping destination to be 42 min, down from 49 min in 1970 (travel time not included; Table 9). An examination of the shopping duration distribution indicates that the greatest change was in the decline in long shopping trips (in excess of 90 min), which can be attributed to time constraints common to multiple-worker households.

It appears that the constraint on people's time was a slightly stronger force, resulting in a decrease in shopping duration. This can be seen in the declining duration at each shopping stop as the trip chain becomes more complex. The amount of time spent shopping in simple chains was 49.8 min, and it declined to 30.8 min for chains of seven and more links, for a difference of almost 20 min. The increasing tendency over time to trip chain makes shopping a more directed activity and is less of a social or recreational experience, which was more frequently the case in the past. This reduces the fuzzy distinction between shopping and recreation, which is common to some shopping trips and which contributes to poorly defined trip purposes in transportation surveys.

Shopping Trip Lengths

There are also at least two competing forces on shopping trip lengths. First, the increased number of shopping sites throughout DuPage County has brought many more shopping choices closer to places of residence and therefore would contribute to shorter shopping trips. Second, the shortest links in 1990 were in the simple chains, which have declined precipitously since 1970 (Table 3). These links averaged 2.5 mi, whereas most others averaged over 3 mi and some averaged more than 4 mi. As these simple chains decline the average distance should increase.

The data show that the change in average shopping trip distance has stayed stable, rising only from 3.08 mi in 1970 to 3.11 mi in 1990 (Table 10). The distance distribution has also changed very little. Approximately 60 percent of all shopping trips in both surveys were less than 2.5 mi, and roughly 1 in 20 was more than 10 mi. Indeed the slight increase in trip length can be attributed to the modest decline in short trips (less than 2.5 mi), many of which were simple chains. It appears that the decline in simple

TABLE 10 Frequencies of Shopping by Distance Categories

Distance (miles)	1970		1990	
	Frequency	Percent	Frequency	Percent
0.0 - 2.49	131,068	62.3	134,594	59.5
2.5 - 4.99	42,335	20.1	52.836	23.3
5.0 - 9.99	27,214	12.9	28,282	12.5
10.0 +	9,786	4.7	10,678	4.7
Total	210,403	100.0	226,399	100.0
Average	3.08 miles		3.11 miles	

chains was stronger than the effect of increased density of stores, which permits shorter trips.

CONCLUSIONS AND IMPLICATIONS

Although there are differences between how 1970 home interview and the 1990 Household Travel Survey data were collected and the questions asked, it is possible to identify broad findings. The most significant finding is that trip making appears to be more efficient and shopping as an activity is declining as the number of per capita work trips rises. There is little change in the number of trips per capita, but since there are more complex trip chains, travelers achieve more out-of-home stops with a fixed number of trips. It takes six trips to visit three places if all are simple chains, but if these six trips are linked in one chain, five places can be visited, almost twice the number. Still the increase of only 8 percent for shopping trips was unexpected, given the population increase and the rising incomes through an expanded labor force.

With the decline in the number of simple shopping chains, which are typically short trips, there is the potential for average trip lengths to increase. This tendency is partially but not completely offset by a greater density of stores, which contributes to shorter trips.

Despite the stable shopping trip distances and the small rise in the total number of shopping trips, highways are becoming more congested, and there are few better examples than DuPage County. In DuPage County the gross densities are very low, the population is affluent, vehicle ownership is high, and the populace is modifying travel behavior by stringing trips together into complex chains. This may be a reaction to less actual or perceived leisure or nonwork time, but the consequence is that the total travel in 1990 was more efficient for the individual than in 1970, but it contributed to severe peaking and congestion.

Contemporary travel behavior increasingly links trips for nonwork activity to the work trip, many of which occur during the peak. It may reduce congestion if trips for nonwork activity were rescheduled to other times, but this would be a return to the 1970 pattern, in which a large number of simple chains characterized household travel. This could add to vehicle miles of travel (VMT) and may not be desirable unless work travel occurred during the off peak or the shoulder of the peak, as would be the case with staggered work hours. These travel patterns also have implications for cold starts, which would also likely increase if chaining declined. Additional work is encouraged to ascertain the merits of peak-hour trip chaining and the trade-off between reduced congestion and increased VMT.

There are also clear implications for trip distribution modeling. These models need to consider more closely the origin and des-

TABLE 9 Frequencies of Shopping by Duration Categories (time spent at each shopping destination; travel not included)

Duration (minutes)	1970 (percent)	1990 (percent)
0 - 14.99	20.6	23.3
15 - 29.99	21.8	25.1
30 - 44.99	17.1	17.8
45 - 59.99	13.9	11.7
60 - 89.99	11.8	13.3
90 +	14.8	8.8
Total	100.0	100.0
Average	49 minutes	42 minutes

tination of the trip since many trips are now made without the home at either end, yet the location of the home is undoubtedly important in selecting nonhome destinations.

This analysis underscores the fact that there are considerable archives of travel data, perhaps more than can be analyzed. Still there are many unverified conjectures about how travel has changed. The authors encourage other work to examine these changes and explore ways that this work can be used to improve the transportation modeling and planning process.

REFERENCES

1. Goulisa, K. G., and R. Kitamura. Recursive Model System for Trip Generation and Trip Chaining. In *Transportation Research Record 1236*, TRB, National Research Council, Washington, D.C., 1989, pp. 59–66.
2. Lerman, S. R. The Use of Disaggregate Choice Models in Semi-Markov Process Models of Trip Chaining Behavior. *Transportation Science*, Vol. 13, 1979, pp. 273–291.
3. Adler, T., and M. Ben-Akiva. A Theoretical and Empirical Model of Trip Chaining Behavior. *Transportation Research B*, Vol. 13, 1979, pp. 243–257.
4. Timmermans, H., X. Van der Hagen, and A. Borgers. Transportation Systems, Retail Environments and Pedestrian Trip Chaining Behavior: Modeling Issues and Applications. *Transportation Research B*, Vol. 26, 1992, pp. 45–59.
5. Oster, C. Second Role of the Work Trip—Visiting Non-Work Destinations. In *Transportation Research Record 728*, TRB, National Research Council, Washington, D.C., 1979, pp. 79–82.
6. Prevedouros, P., and J. Schofer. Suburban Transport Behavior as a Factor in Congestion. In *Transportation Research Record 1237*, TRB, National Research Council, Washington, D.C., 1990, pp. 47–58.
7. Strathman, J. G., K. J. Dueker, and J. S. Davis. Effects of Travel Conditions and Household Structure on Trip Chaining. Presented at 72nd Annual Meeting of the Transportation Research Board, Washington, D.C., January 1993.
8. Horton, F. E., and W. E. Wagner. A Markovian Analysis of Urban Travel Behavior: Pattern Response by Socioeconomic Occupational Groups. In *Highway Research Record 283*, HRB, National Research Council, Washington, D.C., 1969, pp. 19–29.
9. Hanson, S. Urban Travel Linkage: A Review. In *Behavioral Travel Modeling* (D. Hensher and P. Stopher, eds.), Croom Helm, London, 1979, pp. 81–100.
10. Bacon, R. *Consumer Spatial Behavior*. Clarendon Press, Oxford, 1984.
11. Gosh, A., and S. McLafferty. A Model of Consumer Propensity for Multipurpose Shopping. *Geographical Analysis*, Vol. 16, 1984, pp. 244–249.
12. Goulisa, K. G., R. M. Pendyala, and R. Kitamura. Practical Method for the Estimation of Trip Generation and Trip Chaining. In *Transportation Research Record 1285*, TRB, National Research Council, Washington, D.C., 1990, pp. 47–56.
13. Nishii, K., K. Kondo, and R. Kitamura. Empirical Analysis of Trip Chaining. In *Transportation Research Record 1203*, TRB, National Research Council, Washington, D.C., 1988, pp. 48–59.
14. Thill, J. C., and I. Thomas. Toward Conceptualizing Trip-Chaining Behavior: A Review. *Geographical Analysis*, Vol. 19, 1987, pp. 1–17.
15. Borgers, A., and H. Timmermans. A Model of Pedestrian Route Choice and Demand for Retail Facilities Within Inner-City Shopping Areas. *Geographical Analysis*, Vol. 18, 1986, pp. 115–128.
16. Willis, P., and D. Hodge. Trip Chaining in the Puget Sound Region: New Perspectives on Travel Behavior. Presented at 69th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1990.
17. *Chicago Area Transportation Study 1970 Household Travel Surveys*. Final Report. Creighton Hamburg Incorporated, Chicago, Ill., July 6, 1971.
18. CATS Household Travel Surveys, Vol. 1 to 9. Documentation for each of the areas surveyed, Chicago Area Transportation Study, Vol. 1, Sept. 1989, through Vol. 9, Aug. 1993.
19. Kim, H., J. Li, S. Roodman, A. Sen, S. Sööt, and E. Christopher. Factoring Household Travel Surveys. Presented at 72nd Annual Meeting of the Transportation Research Board, Washington, D.C., January 1993.
20. Chicago Area Transportation Study. *Transportation Facts—A Focus on Census Work Trips*, Vol. 10, No. 3, June 1993.
21. O'Kelly, M., and E. Miller. Characteristics of Multistop Multipurpose Travel: An Empirical Study of Trip Length. In *Transportation Research Record 976*, TRB, National Research Council, Washington, D.C., 1984, pp. 33–39.
22. Hu, P., and J. Young. *Summary of Travel Trends, 1990 Nationwide Personal Transportation Survey*. FHWA, U.S. Department of Transportation, March 1992, p. 43.